ABSTRACT

Search for Large, Compactified Extra Dimensions in the Diphoton Channel

Daniel Klein (Cornell University, Ithaca, NY 14853), Tingjun Yang (Fermi National Accelerator Laboratory, Batavia, IL 60510).

The hierarchy problem has puzzled many physicists and represents a major shortcoming of the Standard Model. This problem can be phrased, "Why is gravity so weak compared to the other fundamental forces?" or, alternatively, "Why is the Planck mass scale so large compared to the mass scales of the other fundamental forces?" The ADD model of large extra dimensions posits that the Planck mass is actually of the same order of magnitude (TeV) as the weak mass scale, but it appears so large because gravity can propagate into extra dimensions of space while the other forces cannot, thus apparently rendering it weaker. One consequence of such a theory is that the graviton, a necessarily massless particle, would appear to have nonzero mass when observed in our 3D space. When the graviton decays into two photons, those photons can be measured and used to reconstruct the mass of the original graviton. In this analysis, the differential cross section for ADD and standard model diphoton production was computed and used to perform a Monte Carlo simulation that gave a distribution of diphoton masses. The efficiency of the CDF detector at measuring diphoton mass was calculated using a software package that simulates CDF's response to particle events. That efficiency function was applied to the Monte Carlo simulation data to predict what the observable diphoton mass spectra should look like. After calculating the systematic error in this simulation, the CL_s technique was used to set lower limits on the two fundamental parameters of this model: the effective Planck mass M_s and number of extra dimensions n. At the 95% confidence level we place a lower limit on M_s of 1.76 TeV for $n = 2$, 1.98 TeV for $n = 3$, 1.66 TeV for $n = 4$, 1.50 TeV for $n = 5$, 1.40 TeV for $n = 6$, and 1.32 TeV for $n = 7$. These limits are not substantially more stringent than those set by Fermilab's DØ collaboration two years ago. While our study had five times the luminosity, DØ's study used a greater breadth of signals in their analysis, suggesting that following their procedure using our data will lead to limits on the ADD model parameters that are more stringent than those previously set.